WHAT IS CLAIMED IS:

1.   A non destructive, non contact method for detecting current leakage of a film on a substrate, the method comprising the steps of:

repeatedly irradiating the film with an electron beam, thereby causing the film to emit x-rays,

detecting the emitted x-rays with an x-ray detector,

counting the detected x-rays emitted with each repeated irradiation of the film to produce an x-ray count rate,

determining a trend of the x-ray count rate, and

determining the current leakage of the film from the trend of the x-ray count rate.

2.   The method of claim 1, wherein a trend of decreasing x-ray count rates indicates a relatively low current leakage of the film.

3.   The method of claim 1, wherein a trend of stable x-ray count rates indicates a relatively high current leakage of the film.

4.   The method of claim 1, wherein the substrate is a monolithic semiconductor integrated circuit production substrate.

5.   The method of claim 1, wherein the film is a gate dielectric film.

6.   The method of claim 1, wherein the film is a gate dielectric film in a transistor of a production integrated circuit.

7.   The method of claim 1, wherein the electron beam and the x-ray detector are provided by a spectrometer of a type used for determining elemental composition of the film.

8.   The method of claim 1, wherein the film is between about ten angstroms and about thirty angstroms in thickness.

9.   The method of claim 1, wherein the film is formed of silicon oxide.

10. The method of claim 1, wherein the method is accomplished as part of an integrated circuit fabrication process.

11. The method of claim 1, wherein the x-rays are detected at a nitrogen band energy level.

12. The method of claim 1, wherein the x-rays are detected at an oxygen band energy level.

13. The method of claim 1, wherein the x-rays are detected at both a nitrogen band energy level and an oxygen band energy level.

14. The method of claim 1, wherein the trend of the x-ray count rate is observed while varying an irradiation pulse time and an inter-pulse wait time of the electron beam.

15. The method of claim 1, wherein landing energy is kept below about two and one half times an observed photon energy.

16. A non destructive, non contact method for detecting current leakage of a gate dielectric film in a transistor on a monolithic semiconductor integrated circuit production substrate, the method comprising the steps of:

    repeatedly irradiating the film with an electron beam, thereby causing the film to

5   emit x-rays,

    detecting the emitted x-rays with an x-ray detector,

    counting the detected x-rays emitted with each repeated irradiation of the film to produce an x-ray count rate,

    determining a trend of the x-ray count rate, and

10   determining the current leakage of the film from the trend of the x-ray count rate.

17. The method of claim 16, wherein a trend of decreasing x-ray count rates indicates a relatively low current leakage of the film, and a trend of stable x-ray count rates indicates a relatively high current leakage of the film.

18. The method of claim 16, wherein the electron beam and the x-ray detector are provided by a spectrometer of a type used for determining elemental composition of the film.

19. The method of claim 16, wherein the x-rays are detected at both a nitrogen band energy level and an oxygen band energy level.

20. A non destructive, non contact method for detecting current leakage of a gate dielectric film in a transistor on a monolithic semiconductor integrated circuit production substrate, the method comprising the steps of:

   repeatedly irradiating the film with an electron beam, thereby causing the film to
5   emit x-rays,

   detecting the emitted x-rays with an x-ray detector, wherein the electron beam and the x-ray detector are provided by a spectrometer of a type used for determining elemental composition of the film, and the x-rays are detected at both a nitrogen band energy level and an oxygen band energy level,

10 counting the detected x-rays emitted with each repeated irradiation of the film to produce an x-ray count rate,

   determining a trend of the x-ray count rate, and

   determining the current leakage of the film from the trend of the x-ray count rate,

   wherein a trend of decreasing x-ray count rates indicates a relatively low current
15   leakage of the film, and a trend of stable x-ray count rates indicates a relatively high current leakage of the film.